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Toxicological findings in three cases of suicidal asphyxiation with helium

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ABSTRACT

Introduction: Toxicological findings in deaths by asphyxiation due to a pure inert gas like helium are rare. We present three suicide cases of asphyxial death attributed to anoxia caused by inhalation of helium in a plastic bag positioned over the head.
Methods: In one case, lung tissue, brain tissue and heart blood were obtained during standard autopsy procedures. In two cases, samples were obtained differently: heart blood, femoral blood, brain tissue, lung tissue and/or air from the lungs were directly sealed into headspace vials during autopsy. Air from the lungs was collected using a syringe and transferred into an aluminum gas sampling bag which was heat sealed as soon as possible. Semi-quantitative gas analyses were performed using headspace gas chromatography-thermal conductivity detection (HS-GC/TCD) with a molsieve column capable of separating permanent gasses. Nitrogen was used as carrier gas.
Results: In the first case no helium was detected in lung tissue, brain tissue and heart blood. In the second case the presence of helium was detected in lung tissue (approximately 5% helium in gaseous phase) but not in femoral blood. In the third case the presence of helium was detected in air from the lungs (0.05%), lung tissue (0.4%), brain tissue (0.1%) and heart blood (0.04%).
Conclusions: Helium is easily lost if sampling is not performed properly. The presented cases suggest that quick sample collection of various matrices during autopsy is suitable to detect gasses like helium in postmortem cases. Use of HS-GC/TCD enables to detect an inert gas like helium.

1. Introduction

Since the start of the new millennium, there has been an increase in the number of suicides involving helium [1,2]. On the internet information can be found about euthanasia or committing suicide by inhalation of helium gas without the intervention of a doctor [3].

Helium is a colorless, odorless, tasteless and biological inert noble gas. Inhalation of pure helium which is guided inside a plastic bag or in a mask can cause suffocation by expelling oxygen in the inhaled air.

Physiological effects and symptoms that may occur when breathing air with reduced oxygen are increased heart rate and fatigue (at 21–14% oxygen), hampered moving and thinking (at 14–11% oxygen), development of headaches, dizziness and fainting after a short amount of time, fainting within 8–6 min, resuscitation possible if carried out directly (at 11–8% oxygen) and almost immediately fainting, death or severe brain damage (at 6–0% oxygen) [4].

Observation of two suicides by helium inhalation in a prefilled environment confirmed rapid loss of consciousness and sudden death [5]. As excess of carbon dioxide (instead of lack of oxygen) triggers the breathing reflex and since carbon dioxide is also expelled by helium, the feeling of suffocation and urge to breathe is not present [6]. Unfortunately, especially cases involving inert gases like helium are often presented without detailed toxicological findings [7]. This is probably because gasses like helium can easily be lost during sampling, storage and sample preparation. During autopsy non-specific signs of intoxication may be observed by the pathologist such as brain edema and pulmonary edema. Usually the assignment of suicide by asphyxiation caused by inhalation of helium as the cause of death is based on the presence of paraphernalia such as a plastic bag over the head (or a mask) of the deceased and a commercially available helium cylinder and the absence of a more plausible cause of death. It is however possible that the evidence or paraphernalia are removed from the scene by

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a third party, complicating the pathological and toxicological investigation [8]. A reason for this can for instance be financial, when the life-insurance does not cover a suicide. In cases where the paraphernalia were removed, it may actually be of great importance to prove presence of helium in the body of the deceased.

We report toxicological findings in three suicides committed by use of helium.

2. Case history

2.1. Case 1

A 48 year old man was found alive in the bedroom by family members. Around his head was a (not tightly closed) plastic bag with a plastic tube coming out attached to a gas cylinder with helium.

In the room a manual for suicide on the basis of helium was found, as well as a letter with a wish not to be treated in the case of "early discovery". The family informed the doctor approximately 1.5 h after death. One of the family members was a physician. Autopsy took place approximately one day after death.

The first results of the autopsy were the following. The heart showed a distended and congested right ventricle. Autopsy and further research showed signs of generalized lack of oxygen such as petechia in lungs and renal pelvis. Non-specific signs of intoxication like pulmonary edema, brain edema and a filled bladder were seen. No anatomical cause of death was found.

Results toxicological routine analyses (*see* Section 3.1): Ethanol (alcohol) in femoral blood (0.65 g/L) and urine (0.96 g/L). No evidence was obtained for the presence of drugs, medicines or pesticides.

2.2. Case 2

An 81 year old woman died as a result of asphyxiation by inhalation of helium in a plastic bag fixed over the head. She was wheelchair dependent. An assisted suicide was suspected. Autopsy took place approximately 3 days after death.

The first results of the autopsy were as follows: pulmonary edema, advanced generalized arteriosclerosis and no identifiable anatomical cause of death.

Results toxicological routine analyses (*see* Section 3.1): Ethanol in urine (approximately 0.11 g/L), no ethanol in femoral blood, possibly omeprazole in heart blood. No evidence was obtained for the presence of other drugs, medicines or pesticides.

2.3. Case 3

A 41 year old woman was found lying on a couch in a house by the main occupant, in serious need of resuscitation. According to statements, a gas cylinder would have been present, and possibly a bag around the head. She was said to be resuscitated and the duration of this was not known. Autopsy took place approximately one day after death.

The first results of the autopsy were as follows: The head and neck showed some congestion above the level of the clavicles. The conjunctiva of the left eye contained petechiae. The surface of both lungs showed some petechiae. These findings are non-specific but could indicate a sudden failure of the heart function. Also the finding of lung edema is non-specific. Autopsy revealed no anatomical cause of death.

Results toxicological routine analyses (*see* Section 3.1): Citalopram or escitalopram in femoral blood (0.41 mg/L) and in heart blood (0.46 mg/L); the performed analysis was not able to differ between the isomers of citalopram. No evidence was obtained for the presence of other drugs, medicines or pesticides.

3. Material and methods

3.1. Toxicological routine analysis

In toxicological investigation of autopsy cases at the Netherlands Forensic Institute (NFI), four toxicological analyses are performed routinely to investigate the presence of drugs of abuse, prescription drugs, pesticides and ethanol (alcohol). This was also done for the three cases. A screening for drugs of abuse, medicines and pesticides was performed in whole blood (heart blood) after solid phase extraction (SPE) by using high performance liquid chromatography with diode array detection (HPLC-DAD) and gas chromatography with mass spectrometric detection (GC–MS) after derivitization with bis(trimethylsilyl)trifluoroacetamide (BSTFA) [9]. Secondly, the identification and quantification of 57 substances in whole blood (heart and femoral blood or vitreous humor), including both medicinal and illicit drugs, was performed using a validated UPLC–MS/MS (ultra performance liquid chromatography–tandem mass spectrometry) method [10]. Thirdly, the presence and concentration of GHB in three matrices (femoral blood, heart blood, vitreous humor and/or urine) was determined separately by using GC–MS (gas chromatography mass spectrometry) [11]. And finally, concentrations of alcohol (i.e. ethanol) in the post-mortem cases were determined in two matrices (femoral blood, vitreous humor and/or urine) by head-space gas chromatography with flame ionization detection. The limits of quantification (LOQ) are 0.001 or 0.005 mg/L for all drugs using the UPLC–MS/MS method and 5 mg/L for GHB.

3.2. Semi-quantitative analyses of helium

The method of analysis of helium was largely similar to the assay as published by Schaff et al. [12]. Semi-quantitative gas analyses were performed using headspace gas chromatography-thermal conductivity detection (HS-GC/TCD) with a molsieve column capable of separating permanent gasses. Nitrogen was used as carrier gas. This method is not a routinely used method in forensic toxicological cases at the NFI.

In comparison to Schaff et al. we used a combined column (Varian CP7429, with two columns in parallel, of which only the CP-Molsieve 5A column was used for the helium analysis) with a different column flow and slightly different oven temperature (30 °C instead of 35 °C). Detector settings were almost identical (make-up flow 7 ml/min instead of 5 ml/min). Injector temperature was 50 °C instead of 200 °C). Schaff et al. used a small split ratio. We used a split/splitless injector with a total flow of 50 ml/min which limits the residence time in the liner and accounts for a sharp injection pulse.

As sample preparation, the HS vials were incubated/shaken at 70 °C in the oven of the headspace sampler for 20 min.

The limit of detection is estimated to be approximately 50 ppm, based on the signal to noise ratio in a 100 ppm standard helium in nitrogen. A semi-quantitative result of helium (in gaseous phase) was determined by calibration with (diluted) helium.

3.3. Breath experiment

To get an impression of the helium concentrations in exhaled breath after inhaling pure helium gas, the experiment described by Auwaerter et al. was repeated [13]. A healthy volunteer deeply exhaled and then deeply inhaled helium once from a balloon. The subsequent exhaled breaths were sampled and analyzed.